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PRODUCTIVITY OF MAIZE UNDER WATER STRESS CONDITIONS AND BIOLOGICAL FERTILIZATION IN CALCAREOUS SOILS

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Two field experiments were conducted in 2003 and 2004 summer seasons at Desert Research Center Experimental Station at Maruyt to investigate the response of maize cv. 30B9 to different bio-fertilization treatments (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) and (*Azospirillum lipoferum* + *Bacillus megatherium var. phosphaticum* + *Bacillus sabtilis)* accompanied with two mineral NPK levels (full and half dosages) , under four water regime treatments; which missed one irrigation (the second, the third, or the fourth) beside the normal irrigation treatment as a control.

Results proved that water is a limiting production factor of maize plants; meanwhile maize plants can tolerate water scarcity at the vegetative growth period (60 days). Missing the fourth followed by the third irrigation seemed to be the worst treatments compared with the other treatments, while missing the second irrigation treatment seemed to be the best after the control one.

The application of the bio-fertilization treatments help the plants to overcome the bad effects of water stress at any growth period. The first bio-fertilizer (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) seemed to be more successive under water stress conditions compared with the other treatment (*Azospirillum lipoferum* + *B. megatherium var. phosphaticum* + *B. sabtilis)*. Under the normal irrigation conditions, the full dosage of the mineral NPK fertilizers seems to be the best followed by both first and the second bio fertilizers accompanied with the half dosage of the mineral NPK .When taking into consideration the environmental expenses , using the half dosage of the mineral NPK + the bio fertilizers will be more logic.

Results indicated that under normal irrigation, the full dosage of mineral NPK fertilizers followed by the combination of both the first then the second bio-fertilizer and half dosage of mineral NPK increased significantly the plant growth parameters (plant height, plant fresh , dry weights, and leaf area), in addition it increased significantly pigments accumulation, total chlorophyll content, N, P and K. These results increased significantly ear weight, number of grains per ear, 100 grain weight, consequently biological and grain yield.

Keywords: maize, biological fertilization, *Azotobacter crococcum*, mycorrhiza, *Pseudomonas* spp. *Azospirillum lipoferum*, *Bacillus megatherium var. phosphaticum*, *Bacillus sabtilis*, growth characters, total pigments, total chlorophyll, N, P, K, yield parameters, biological and grain yield.

The critical period of plant growth usually starts at the time when reproductive organs are formed, and pollination and fertilization take place. Therefore, each unit of water should be used effectively and equitably. Hence, the development of such important crops as maize with high and stable yield under low moisture is an important priority for today's needs on both national and international levels.

Maize is known for its numerous industrial uses like corn bread, corn chips, paper, insulator, card board, pipes, chemicals, plastics, methanol, tar, green corn, baby corn, starch, glucose and oil, besides human and animal consumption.

When taking into consideration the comparative importance of water, maize plant is considered as a very sensitive crop to water stress especially at the reproductive phase. Plants can tolerate the water stress in the vegetative growth period compared with the other growth periods, in other words, the total sensitive period to water stress equals the last 55 days of plant growth (Wenmead and Shaw, 1960; Norwood and Dumler, 2001 and Nathan *et al.* 2005).

In Egypt, maize plant is considered one of the main grain crops, and during the last period it became one of the most important goals of the Egyptian government to increase the maize production in order to face the human and animal essential needs. In this respect, continuous extension efforts had been done at both horizontal and vertical levels.

Many challenges faced all efforts made in this target, the challenges concentrated in irrigation water scarcity associated with inapplicable fertilization treatments, and the pollution made by the fertilizers itself particularly under new reclaimed soil conditions (Reiad *et al.*, 1987 and Todd and Larry, 2005).

Maize plant is considered as a greedy plant to fertilization, particularly to nitrogen when irrigation water is available (Nour El-Din *et al.* 1975; Yakout *et al.*, 1980 and Reiad *et al.*, 1987), but when there is a scarcity in irrigation water, fertilization is not an acceptable risk. Therefore, biological fertilizers may supply maize plant with all nutrients needed for plant metabolism and growth without all hazards occurred when applying chemical fertilizers under water stress conditions.

Many reports declared the associations of N_2 fixing bacteria, phosphate bacteria, and mycorrhiza with plant root system (Neyra and Doberiener, 1978, and Van Berkum and Bohlool, 1980; Schroeder and Janos, 2005). Other investigators reported that under water stress, the bio-fertilizers helped the plants to overcome the bad effects of water stress, and increased significantly all growth characters, chemical composition, hence yield and its attributes (Goicoechea *et al.*, 1997; Schweigera and Jakobsenb,1999; Mozafara *et al.*, 2000; Egamberdiyeva *et al.*, 2002 and El Hawary *et al.*, 2002).

The present study evaluate maize growth, chemical composition and productivity under the effect of two bio-fertilizers (NPK) associated with either 0 %, 50% or 100 % of chemical NPK fertilizers under different water regime treatments during the vegetative growth period.

MATERIALS AND METHODS

Two field experiments were conducted in 2003 and 2004 summer seasons at Desert Research Center Experimental Station at Maruyt to investigate the response of maize plant (*Zea mays* L. var. pioneer 30B9) to different bio-fertilization treatments (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) and (*Azospirillum lipoferum*+ *B. megatherium var. phosphaticum* +*B. sabtilis)* accompanied with two mineral NPK levels {full (100 %) and half (50%) dosages}, under four water regime treatments; which included missed one irrigation treatment after El-mohayah irrigation 10 days after germination, {the 2nd irrigation (25 days after germination), the 3rd irrigation (40 days after germination), or the 4th irrigation (55 days after germination) }beside the normal irrigation treatment as a control.

Inoculants used consisted of three strains of every microorganism to protect bacteriofage in the rhizosphere. These strains were kindly provided from microbial research center (Cairo MIRCEN), The Unit of Biofertilizers, Faculty of Agriculture, Ain Shams University, Cairo.

The inoculated maize plant received 3 ml of inocula / hill just before the first irrigation (El-mohayah). Bacterial cultures used for inocula normally had a cell density of 10 with 10^6 /plant , where Mycorrhiza was 60 spore /plant. They were grown in a liquid medium containing 1 g NH_4Cl/liter (Okon *et al.*, 1976), consequently, spores of Mycorrhiza were isolated from the soil by the wet sieving and decanting method (Gerdemann and Nicolson, 1963).

Compost (complete fermented organic materials) was added into the soil during soil preparation in the dosage 20 kg/ fed accompanied with phosphorous as calcium super phosphate 16% P_2O_5 in the rate 15 and 30 kg P_2O/ fed following the treatments scheme.

The other chemical fertilizers were added as complete and half of the recommended dosage i.e., nitrogen as ammonium nitrate 33.5% N in the rate 60 and 120 kg N/ fed., while potassium was added as potassium sulfate 40% K_2O in the rate 12 and 24 kg K_2O/fed in two equal dosage added just before the first and second irrigation.

Spilt split plot design in four replicates was used in this experiment, where irrigation treatments occupied the main plots, chemical fertilizers in the sub-main, and bio-fertilizers in the sub-sub main plots.

The experimental plot area was 14.20 m^2 with four rows of 4 m in length and 71 cm in width. Two grains per hill were sown in the first of June in both seasons at distance of 20 cm. Plants were thinned after 25 days from sowing to one plant/hill.

Samples were taken one week after applying the fourth irrigation for studying some growth characters i.e. plant height (cm/plant), number of leaves/ plant, fresh and dry weights (g/plant), third leaf area (cm^2) (using "Li-3000A" portable leaf area meter) and chemical composition i.e. total nitrogen percentage following the method described by Paech and Tracey (1956), potassium percentage referring to (Johnson and Ulrich, 1961) method, phosphorous percentage following the method described by John (1970) and total pigments using SPDA-502 leaf chlorophyll meter, then converted into total chlorophyll (a+b) as μ mole m $^{-2}$ referring to the equation published by John *et al.* (1988). Similarly, yield and its components were evaluated at harvest time i.e., ear weight/ cm , number of grains/ ear, seed index (as 100 grain weight /g), biological and grain yield (ton/fed).

Data obtained was exposed to the proper method of statistical analysis of variance (ANOVA) as described by Steal and Torrie (1960) and Duncan's new multiple range test was used to differentiate between means as described by Duncan (1955).

RESULTS

Effect of Irrigation Treatments

Results (Table 1) indicated that there were significant differences between irrigation treatments i.e. normal irrigation treatment (without missing any irrigation) seemed to be the superior irrigation treatment to enhance all growth characters i.e. plant height, fresh and dry weights, number of leaves and leaf area, followed by the other treatments including (missing either the second, the third or the fourth irrigation) respectively.

Similarly, table (1) water stress reduced significantly the absorption of nitrogen, phosphorous and potassium by plant, hence total pigments and total chlorophyll accumulation. Plants under missing the fourth irrigation had the lowest growth characters and chemical composition if compared gradually with missing the third, the second or the normal irrigation treatment as a best one. These results can clarify the unfavorable obtained growth characters as a result of low plant nutrition.

As indicated in table (1), water stress affected negatively ear weight, number of grains per ear, 100 grain weight, hence, both biological and grain yield. It could be concluded that the more advanced growth stage is the more sensitive to water stress in maize plants. Meanwhile, when there is a scarcity of water irrigation missing the second irrigation at 25 days may produce appreciated grain yield (2.7 ton/fed.) compared with missing the third (2.3 ton/fed) and the fourth irrigation (1.8 ton/fed).

Effect of Bio-fertilization Treatments

Results in table (2) indicated that using the bio-fertilizer-1 which consist of (*Azotobacter crococcum* + Mycorrhiza + *Pseudomonas* spp) was more superior if compared with the bio-fertilizer -2 which consist of *Azospirillum lipoferum* + *B. megatherium var. phosphaticum* +*B. sabtilis*. Bio-fertilizert-1 enhanced all studied growth characters i.e. plant height, fresh and dry weights, number of leaves per plant and leaf area. Nevertheless, it led to enhance NPK absorption by plants; as a result plant total pigments and total chlorophyll content were significantly increased. Accordingly using biofertilizer-1 increased significantly all studied yield components, hence biological and grain yield ton/fed.

Effect of NPK Fertilization Treatments

When study the chemical fertilization effects, results in table (3) clarify that the usage of chemical NPK fertilization increased significantly all studied growth characters, which led to significant increase in all studied plant chemical composition. Both growth and chemical composition observations in table (3) escorted the high yield components, biological and grain yield obtained in table (3). Mineral fertilization may seems to be more applicable to get an appreciated yield if compared with bio-fertilizers application from commercial sight of view, as a result of highly response of maize plants to fertilization particularly to nitrogen. But when calculate the environmental costs which include the water, air and soil pollution, chemical fertilization bill will have high environmentally costs if compared with the bio-fertilizers application, especially when an appreciated yield is obtained and particularly if there is no significant differences in both biological yield and grain yield were observed. This was noticed by applying bio-fertilizer-1 as compared with 100 % NPK chemical fertilizers as presented in table (3).

Effect of Bio-fertilization Treatments Under Different NPK Levels

When the two bio-fertilizers efficiency studied under different mineral NPK levels, Bio-fertilizer-1 seemed to be more successive under 50% of the recommended NPK dosage comparing with the Bio-fertilizer-2. Both bio-fertilizers treatments increased significantly all studied maize plants growth characters and chemical composition which significantly increases in all studied yield components, biological and grain yield as well as indicated in table (4).

When 100% of the recommended NPK chemical fertilizer dosage was applied together with bio-fertilizer 1 or 2, significant decrease obtained in each of all studied growth characters, chemical composition, yield and its components of maize plants as presented in table (4) respectively as compared with the combination included 50% of mineral NPK application and either bio-fertilizer 1 or 2.

Effect of Bio-fertilization Treatments Under Different Irrigation Treatments

Consequently, when study the behavior of the two bio-fertilizers under different irrigation treatments, bio-fertilizer-1 seems to be superior when compared with bio-fertilizer-2, especially when water stress is existed. Under the severe water stress conditions as the fourth irrigation is escaped due to irrigation water deficit, bio-fertilizer 1 then 2 remained capable to increase all yield components in addition to biological and grain yield as a result of enhancing significantly all studied plant chemical composition, thus all studied growth characters table (5).

Similarly, when missing either 2nd or 3rd irrigation, water stress may not be as much of missing the 4th irrigation, though each of bio-fertilizer 1 then 2 could easily encourage significantly all studied growth characters as a result of increasing significantly plant chemical composition thus, yield and its attributes table (5).

When irrigation water is adequate enough to provide maize with its water requirements, although the dosage 100% of NPK is highly recommended for maize production because it is greedy to fertilizers particularly to nitrogen, but it is highly environmentally costing at the same time. So that, bio-fertilizer-1 was superior to encourage all studied plant growth characters, chemical compositions, and therefore yield and its attributes compared with either bio-fertilizer-2 or the dosage 50% of NPK.

Effect of NPK Fertilization Treatments Under Different Irrigation Treatments

Under normal irrigation treatment, 100% of NPK was the recommended treatment to enhance all studied growth characters, chemical composition, yield and its components when comparing with 50% of NPK as indicated in table (6).

TABLE (1). Effect of irrigation treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Growth Characters																			
Plant height /cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2
240 A	17.6 A	845.2 A	158.6 A	510.7 A	212.7 B	15.3 B	608.4 B	112.4 B	435.2 B	197.1 C	14 C	510 C	90 C	381 C	160.1 D	12.4 D	388.3 D	65.2 D	299.3 D
Chemical composition																			
Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m^{-2}	% N	% P	% K
53.4 A	741.5 A	1.73 A	0.95 A	2.88 A	47.7 B	631 B	1.45 B	0.73 B	2.45 B	44.1 C	534.4 C	1.24 C	0.62 C	2.36 C	37.8 D	416.4 D	1.06 D	0.53 D	1.98 D
Yield and its components																			
Ear Weight /g	No Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight
342.1 A	531.7 A	8.06 A	3.28 A	27.38 A	326.6 B	449.5 B	6.5 B	2.78 B	23.13 B	242.9 C	844.2 C	5.3 C	2.3 C	94.4 C	178.6 D	633 D	4.0 D	1.8 D	14.8 D

Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (2). Effect of bio-fertilization treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Treatments		Bio- Fertilizer 1	Bio- Fertilizer 2	Control
				NPK 100%
Studied Characters				
Growth Characters	Plant height /cm	207.1 A	202.7 B	204 A
	No. leaves /Plant	14.95 B	14.5 B	15.8 A
	Fresh weight g/Plant	600.3 B	583.4 C	658.7 A
	Dry weight g/Plant	109.4 B	101 C	168.3 A
	Leaf Area /cm^2	466.1 A	404.2 B	425.8 A
Chemical Composition	Total Pigments	46.9 A	45.3 B	46.7 A
	Chlorophyll μ mol m^{-2}	597.7 A	581.3 B	601.2 A
	% N	1.41 A	1.39 A	1.38 A
	% P	0.72 AB	0.71 B	0.75 A
	% K	2.40 B	2.40 B	2.93 A
Yield and Its components	Ear Weight /g	292.4 A	264.4 B	276.4 A
	No. Grains /ear	420.8 A	409.5 B	422.8 A
	Bio yield T/fed	6.14 A	5.93 B	6.26 A
	Grain yield T/fed	2.61 A	2.54 B	2.65 A
	100 grain weight/g	21.73 B	21.15 B	22.1 A

- Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (3). Effect of NPK mineral fertilization treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Treatments		Control	
		NPK 50%	NPK 100%
Studied Characters			
Growth Characters	Plant height /cm	186.6 B	204 A
	No. leaves /Plant	13.9 B	15.8 A
	Fresh weight g/Plant	496.2 B	658.7 A
	Dry weight g/Plant	87.1 B	168.3 A
	Leaf Area /cm^2	365.8 B	425.8 A
Chemical Composition	Total Pigments	42.1 B	46.7 A
	Chlorophyll μ mol m^{-2}	508.4 B	601.2 A
	% N	1.21 B	1.38 A
	% P	0.63 B	0.75 A
	% K	2.87 B	2.93 A
Yield and Its components	Ear Weight /g	233.9 B	276.4 A
	No. Grains /ear	342.3 B	422.8 A
	Bio yield T/fed	5.28 B	6.26 A
	Grain yield T/fed	2.25 B	2.65 A
	100 grain weight/g	18.72 B	22.1 A

- Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (4): Effect of the interaction between bio-fertilization and NPK fertilization treatments on some studied growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Treatments		Bio- Fertilizer 1		Bio- Fertilizer 2		Control
		NPK 50%	NPK 100%	NPK 50%	NPK 100%	NPK 100%
Studied Characters						
Growth Characters	Plant height /cm	216.6 A	206.7C	210.7B	203.1 D	204.1 D
	No. leaves /Plant	15.4 A	14.8 B	15.1 A	14.8 B	15.8 A
	Fresh weight g/Plant	649 A	599 B	629.5A	580.1 B	658.7 A
	Dry weight g/Plant	117.3 A	109.4B	112.9A	105.5 B	118.3 A
	Leaf Area /cm^2	438.5 A	415.3B	424.8A	403.5 B	425.8 A
Chemical Composition	Total Pigments	48.2 A	46.9 A	47.6 B	46.1 C	46.7 C
	Chlorophyll µ mol m^{-2}	632.1 A	596.8A	619.9A	580.4 B	601.2 A
	% N	1.44 A	1.40 B	1.43 A	1.40 B	1.38 B
	% P	0.77 A	0.71 C	0.74 B	0.70 C	0.75 B
	% K	2.48 A	2.38 B	2.44 B	2.34 B	2.84 A
Yield and Its components	Ear Weight /g	284.2 A	345.4A	276.2C	265.1 C	276.4 C
	No. Grains /ear	445.8 A	418.3A	428.3B	410.7 E	422.8 B
	Bio yield T/fed	6.57 A	6.13 C	6.34 B	5.8 D	6.26 B
	Grain yield T/fed	2.73 A	2.6 C	2.65 B	2.54 C	2.65 B
	100 grain weight/g	22.73 A	21.64C	22.09B	21.21 C	22.1 B

- Means having the same capital letters in the same row are not significantly differed at $P \geq 0.05$

TABLE (5). Effect of the interaction between irrigation and bio-fertilization treatments on some growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation / Fertilization	Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Growth Characters																				
	Plant height /cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^{2}	Plant height g/cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^{2}	Plant height /cm	No leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^{2}	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^{2}
Bio-fertilizer 1	242.7 Ba	17.6 Ba	839.8 Ba	157.1 Ba	489.1 Ba	213.7 Bb	15.3 Bb	613.4 Bb	113.7 Bb	438.7 Bb	200.3 Ab	14 Ac	523 Ac	93.7 Ac	391.4 Ac	171.6 Ad	12.9 Ad	425.2 Ad	73.1 Ad	324 Ad
Bio-fertilizer 2	236 Ca	17 Ca	805 Ca	148.3 Ca	491.5 Ca	211.7 Cb	15.1 Bb	600.4 Cb	110.3 Cb	434 Cb	198.5 Ac	14 Ac	514.7 Bc	91.3 Bc	383.5 Bc	164.5 Bd	12.7 Bd	413.3 Bd	72.3 Bd	307.7 Bd
100 % NPK	261 Aa	21.3 Aa	1123 Aa	214 Aa	618.4 Aa	221 Ab	16 Ab	689 Ab	126.8 Ab	455.6 Ab	190.6 Bc	14 Ac	482 Cc	83.8 Cc	363.2 Cc	143.7 Cd	12 Cd	340.6 Cd	48.7 Cd	266 Cd
Chemical Composition																				
	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K	Pigm-ents	Chlor-ophyll μ mol m^{-2}	% N	% P	% K
Bio-fertilizer 1	63.6 Ba	745.2 Ba	1.76 Ba	0.96 Ba	2.64 Ba	49.1 Ab	640.4 Bb	1.46 Bb	0.74 Bb	2.45 Bb	44.9 Ac	550.7 Ac	1.26 Ac	0.63 Ac	2.37 Ac	39.9 Ad	454.5 Ad	1.17 Ad	0.56 Ad	2.15 Ad
Bio-fertilizer 2	52.8 Ca	726.4 Ca	1.70 Ca	0.93 Ba	2.54 Ca	48.3 Bb	622.5 Cb	1.45 Bb	0.72 Cb	2.45 Bb	44.5 Ac	541.9 Bc	1.24 Bc	0.62 Ac	2.37 Ac	39.1 Bd	434.2 Bd	1.16 Bd	0.55 Bd	2.08 Bd
100 % NPK	57.3 Aa	838.6 Aa	1.91 Aa	1.05 Aa	5.0 Aa	50.6 Ab	674.2 Ab	1.50 Ab	0.82 Ab	2.50 Ab	43 Bc	512.1 Cc	1.21 Cc	0.60 Bc	2.32 Bc	35.7 Cd	379.7 Cd	0.89 Cd	0.51 Cd	1.92 Cd
Yield and its components																				
	Ear Weight /cm	No Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /cm	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight
Bio-fertilizer 1	432.1 Ba	529.3 Ba	8.1 Ba	3.3 Ba	27.4 Ba	392.2 Ab	454.8 Bb	6.6 Bb	2.8 Ab	23.3 Ab	252.8 Ac	402.9 Ac	5.5 Ac	2.4 Ac	20.2 Ac	182.4 Ad	296 Ad	4.3 Ad	2.1 Ad	15.93 Ad
Bio-fertilizer 2	331.1 Ca	514.7 Ca	7.8 Ca	3.2 Ca	26.5 Ca	287.5 Cb	447.2 Cb	6.4 Cb	2.8 Ab	23.0 Ab	246.7 Bc	394.1 Bc	5.3 Bc	2.4 Ac	19.7 Bc	192.1 Ad	282 Bd	4.1 Ad	1.8 Bd	15.4 Bd
100 % NPK	410.3 Aa	641.3 Aa	9.6 Aa	3.9 Aa	32.8 Aa	303.7 Bb	470.7 Ab	7.0 Ab	2.9 Ab	24.3 Ab	227.7 Cc	362 Cc	5 Cc	2.2 Bc	18.2 Cc	164 Bd	217 Cd	3.5 Bd	1.6 Cd	13.1 Cd

Means having the same capital letters (in the same column) and same small letters (in the same row)are not significantly differed at $P \geq 0.05$

TABLE [illegible]: Effect of the interaction between irrigation and NPK mineral fertilization treatments on some growth characters, chemical composition, yield and its components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation Fertilization	Normal irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Growth Characters																				
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50 % NPK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100 % NPK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chemical Composition																				
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50 % NPK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100 % NPK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Yield and its components																				
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
50 % NPK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
100 % NPK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE (7). Effect of the interaction between irrigation, bio-fertilization and NPK mineral fertilization treatments on some growth characters of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation		Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Bio fertili-zation	Mineral fert	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height g/cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2	Plant height /cm	No. leaves /plant	Fresh weight g/plant	Dry weight g/plant	Leaf area /cm^2
Bio-fertilizer 1	0	230.7 Ea	17 Da	755 EFa	143.3 DEa	481.2 EFa	207.3 CDb	15 Bb	579.3 Bb	108 Db	432.2 BCb	197.3 BCc	14 Ac	492 ABCc	89.7 ABc	376.2 CDc	156.7 Ed	12.7 Ad	385.7 BCd	65.5 BCd	288 Cd
	50%	255.6 Ba	18.7 Ba	941.3 Ba	170 Ba	549.2 Ba	220.3 Ab	16 Ab	657 Ab	121 ABb	445.6 BCb	202.6 Ac	14 Ac	543 Ac	97.8 Ac	404 ABc	188 Ad	13 Ad	454.7 Ad	80.4 Ad	355 Ad
	100%	241.7 Ca	17 Da	823 Da	158.1 BCa	499.8 Da	214 Bb	15 Bb	604 Bb	112.2 Cb	438.4 BCb	201 Ac	14 Ac	534 ABc	93.6 Ac	394 ABc	170 Cd	13 Ad	435.3 ABd	73.5 ABd	329 Bd
Bio-fertilizer 2	0	226.7 Fa	16 Ea	741 Fa	134.2 Ea	468 FGa	206.7 CDb	15 Bb	559.3 BCb	105.2 Db	423.3 Cb	195 Cc	14 Ac	490 ABCc	87.4 ABc	368.6 CDc	148.7 Fd	12 Bd	371.6 Cd	57.2 CDd	278 CDd
	50%	244.3 Ca	18 Ca	881.3 Ca	161.8 Ba	518.8 Ca	218.3 Ab	15.3 Bb	657 Ab	116.6 BCb	441.2 BCb	201.3 Ac	14 Ac	535 ABc	94.5 Ac	396 ABc	178.7 Bd	13 Ad	444.7 Ad	78.6 Ad	343 ABd
	100%	237 Da	17 Da	792.7 DEa	148.9 CDa	487.8 DEa	210 Cb	15 Bb	585 Bb	109 CDb	437.6 BCb	199.3 ABc	14 Ac	519 ABCc	92 ABc	386 BCc	166 Dd	13 Ad	423.6 ABd	72 ABd	302 Cd
Control	50%	223.3 Fa	16 Ea	714 Fa	129.4 Ea	462 Ga	204 Db	15 Bb	544.6 Cb	101.1 Db	408 Db	190 Dc	13.7 Ac	475.7 BCc	81.3 Bc	360 Dc	129 Hd	10.7 Cd	250.3 Dd	36.5 Ed	233 Dd
	100%	261 Aa	21.3 Aa	1123 Aa	214 Aa	618.4 Aa	221 Ab	16 Ab	689 Ab	126.8 Ab	455.6 ABb	190.6 Dc	14 Ac	482 BCc	83.8 Bc	363.2 Dc	143.7 Gd	12 Bd	340.6 Cd	48.7 Dd	266 Ad

Means having the same capital letters (in the same column) and same small letters (in the same row) are not significantly differed at $P \geq 0.05$

TABLE (8). Effect of the interaction between irrigation, bio-fertilization and NPK mineral fertilization treatments on chemical composition of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation		Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Bio fertilization	Mineral fert	Pigm-ents	Chlor ophyll µ mol m $^{-2}$	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m $^{-2}$	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m $^{-2}$	% N	% P	% K	Pigm-ents	Chlor ophyll µ mol m $^{-2}$	% N	% P	% K
Bio-fertilizer 1	0	51.5 DEa	690.5 Ea	1.66 Da	0.90 CDa	2.54 Ca	47.9 Deb	613 FGb	1.44 ABb	0.69 Eb	2.43 ABb	44 Dc	530.7 Dc	1.24 ABCc	0.61 Bc	2.34 Ac	38.2 CDd	422.4 CDd	1.14 CDd	0.55 Cd	2.07 Abd
	50%	56.2 Aa	810.3 Ba	1.90 Aa	1.05 Aa	2.8 Ba	50.2 ABb	665.8 BCb	1.48 ABb	0.79 ABb	2.47 ABb	46 ABc	572.4 ABc	1.29 Ac	0.65 ABc	2.41 Ac	41.3 Ad	480 Ad	1.19 Abd	0.58 Abd	2.25 Ad
	100%	53.1 Ca	734.7 Da	1.71 Ca	0.92 Ca	2.58 Ca	49.2 Cb	642.4 Deb	1.45 ABb	0.73 CDb	2.45 ABb	44.8 Cc	549 CDc	1.25 ABCc	0.62 Bc	2.37 Ac	40.3 Abd	461.1 Dd	1.17 Bd	0.56 Bd	2.12 Abd
Bio-fertilizer 2	0	51.1 EFa	685.7 EFa	1.60 Ea	0.88 Da	2.52 Ca	47.1 Deb	596.4 GHb	1.43 Bb	0.69 Eb	2.43 ABb	43.7 Dc	526 Dc	1.22 BCc	0.61 BCc	2.33 Ac	37.3 Dd	406.1 Dd	1.12 Dd	0.52 Cd	1.98 Bd
	50%	54.7 Ba	771.6 Ca	1.81 Ba	1.00 Ba	2.7 BCa	49.5 BCb	649.2 CDb	1.46 ABb	0.76 BCb	2.46 ABb	45.3 BCc	558.8 BCc	1.27 ABc	0.63 BCc	2.41 Ac	40.8 Ad	469.8 Ad	1.18 Abd	0.57 Bd	2.17 Abd
	100%	52.6 CDa	722 Da	1.70 CDa	0.91 Ca	2.45 Ca	48.3 CDb	621.8 EFb	1.45 ABb	0.71 Deb	2.45 ABb	44.4 CDc	540.8 CDc	1.24 ABCc	0.62 Bc	2.36 Ac	39 BCd	436.8 Cd	1.19 Abd	0.56 BCd	2.10 Abd
Control	50%	50.8 Ea	678.8 EFa	1.58 Ea	0.86 Da	2.51 Ca	46.6 EFb	585.1 HIb	1.42 Bb	0.67 Eb	2.42 Bb	41.6 EFc	485 Fc	1.20 Cc	0.59 BCc	2.30 Ac	29.4 Fd	285 Fd	0.63 Fd	0.38 Ed	1.26 Cd
	100%	57.3 Aa	838.6 Aa	1.91 Aa	1.05 Aa	5.0 Aa	50.6 ABb	674.2 ABb	1.50 Ab	0.82 Ab	2.50 ABb	43 DEc	512.1 Ec	1.21 BCc	0.60 BCc	2.32 Ac	35.7 Ed	379.7 Ed	0.89 Ed	0.51 Dd	1.92 Bd

Means having the same capital letters (in the same column) and same small letters (in the same row) are not significantly differed at $P \geq 0.05$

TABLE (9). Effect of the interaction between irrigation , bio-fertilization and NPK mineral fertilization treatments on yield and yield components of maize plants (combined analysis of 2003 and 2004 growing seasons).

Irrigation		Normal Irrigation					Missing second irrigation					Missing third irrigation					Missing fourth irrigation				
Bio. fertilization	Mineral fert.	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight	Ear Weight /g	No. Grains /ear	Bio yield T/fed	Grain yield T/fed	100 grain weight
Bio-fertilizer 1	0	326.3 Ea	497.3 Ea	7.436 Fa	3.132 Ea	26.11 Ea	279.7 CDb	441 Deb	6.328 Eb	2.684 CDb	22.37 CDb	245 Cc	388.7 CDc	5.196 DEc	2.352 Cc	19.6 Cc	139.3 CDd	266 Dd	3.900 Dd	1.817 CDd	15.15 CDd
	50%	361.3 Ba	564.7 Ba	8.768 Ba	3.468 Ba	28.91 Ba	301.7 Ab	468 ABb	6.896 Bb	2.896 Ab	24.13 Ab	262 Ac	419.3 Ac	5.900 Ac	2.515 Ac	20.96 Ac	211.7 Ad	331 Ad	4.720 Ad	2.032 Ad	16.93 Ad
	100%	338.7 CDa	526 CDa	8.108 Da	3.251 CDa	27.1 CDa	595.3 ABb	455.3 CDb	6.512 Db	2.835 ABb	23.63 ABb	251.3 BCc	400.7 BCc	5.488 Cc	2.412 BCc	20.11 BCc	196.3 BCd	291 BCd	4.412 Bd	1.884 BCd	15.71 BCd
Bio-fertilizer 2	0	315.3 Fa	490 EFa	7.200 Ga	3.027 Fa	25.23 Fa	275 DFb	431.7 Eb	6.160 Fb	2.640 DFb	22.01 DFb	236 Dc	379.7 Dc	5.080 EFc	2.265 Dc	18.88 Dc	181 Dd	257 Dd	3.744 Ed	1.737 Dd	14.48 Dd
	50%	346 Ca	539.3 Ca	8.428 Ca	3.321 Ca	27.68 Ca	300.3 Ab	462 BCb	6.716 Cb	2.883 Aa	24.03 Ab	255.7 ABc	406.7 ABc	5.636 Bc	2.454 ABc	20.45 ABc	202.7 Bd	305 Bd	4.588 Ad	1.945 Bd	16.21 Bd
	100%	332 DEa	514.7 Da	7.832 Ea	3.187 DEa	26.56 DEa	287.3 BCb	448 Db	6.380 Deb	2.758 BCb	22.99 BCb	248.3 BCc	396 BCc	5.312 Dc	2.384 BCc	19.87 BCc	192.7 Cd	284 Cd	4.092 Cd	1.849 Cd	15.41 Cd
Control	50%	307.3 FGa	480 FGa	7.120 GHa	2.950 FGa	24.59 FGa	269.7 Fb	420 EFb	6.020 Gb	2.588 Eb	21.57 Eb	217.3 Ec	340 Fc	4.868 Gc	2.086 Ec	17.39 Ec	141.3 Fd	129 Fd	3.096 Gd	1.356 Fd	11.31 Fd
	100%	410.3 Aa	641.3 Aa	9.584 Aa	3.939 Aa	32.83 A	303.7 Ab	470.7 ABb	6.984 ABb	2.915 Ab	24.29 Ab	227.7 Dc	362 Ec	4.992 FGc	2.185 Dc	18.21 Dc	164 Ed	217 Fd	3.488 Fd	1.574 Ed	13.12 Ed

Means having the same capital letters (in the same column) and same small letters (in the same row) are not significantly differed at P ≥ 0.05

Effect of Bio-fertilization Treatments Under Different Irrigation and NPK Fertilization Treatments

The combination of bio-fertilizer-1 with 50% of NPK was the superior in order to encourage significantly all studied characters as indicated in tables (7,8 and 9) respectively.

Under the moderate water stress, when the second irrigation is absent, the combination of bio-fertilizer-1 with 50% NPK was capable to overcome all bad effects obtained from water stress and could significantly encourage all studied growth characters, chemical composition and yield and its components as presented in tables (7,8 and9). The second recommended treatment under these conditions was bio-fertilizer-2 with 50% NPK.

When missing the 3rd or the 4th irrigation, plants will face the challenges of the severe water stress conditions. Only bio-fertilizer-1 with 50% NPK and bio-fertilizer-2 with 50% NPK were able to overcome the unfavorable growth conditions and could significantly improve all studied growth characters, hence chemical composition, yield and its components as presented in tables (7,8 and9).

DISCUSSION

As it is well known, maize plant is a very sensitive crop to water stress especially at the reproductive phase. Plants can tolerate the water stress in the vegetative growth period compared with the other growth periods (Wenmead and Shaw, 1960).

Results indicated that three irrigation treatments out of four were in the vegetative growth, while the fourth one lied between both of the end of the vegetative growth and the beginning of the reproductive growth period. In another word, the first three irrigation treatments were applied in the juvenile period, while the fourth one was in the beginning of maturity.

Many investigators indicated that plants in juvenility can tolerate and overcome the unfavorable growth conditions such as water stress, salinity or even heat stress rather than those in maturity. Plants in juvenile have high concentration of growth promoters such as IAA, GA_3 and CKs. It helps significantly in compensating any decrease may happened in photosynthesis pathway, water and minerals absorption and finally general decay in plant metabolism as a result of producing inhibitors such as ethylene and ABA when stress occurs (Muhammad, 2005; Nathan *et al.*, 2005).

Similarly, at maturity plants generally have high concentrations of the inhibitors comparing with the promoters; the way it encourages assimilates transportation from sources to sinks accompanied with recognizable decay in plant growth and metabolism, to reach early the end of life cycle by producing the fruity parts (Devieln, 1969; Al-Kaisi and Xinhua, 2005). This can clarify the results obtained in this study when taking into consideration the hazard effects of water stress on maize plants growth, chemical composition therefore yield and its components especially at the end of the juvenility compared with the early juvenile growth period.

Several investigators reported that maize plant is considered as one of the greediest crops to use fertilizers particularly to nitrogen. Nitrogen is one of the major elements which encourage assimilates metabolism and transportation, through encouraging plant photosynthesis rate. (Moursi *et al.*, 1970; Ibrahim *et al.*, 1979; Moursi *et al.*, 1983; Reiad *et al.*, 1987). This can simplify the appreciated observations obtained as a result of adding the full dosage of NPK fertilization when compared with the half dosage fertilization or with applying both of the bio-fertilizers under investigation.

The biological fertilization may consider as the only available solution to apply fertilizers when there is irrigation water scarcity. Positive plant growth responses after inoculation with associated N_2 fixing bacteria were found by several investigators under water stress conditions (Nur *et al.*, 1980).

Perhaps the superior results obtained when applying bio-fertilizer-1 rather than bio-fertilizer-2, may be achieved as a consequence of the micro-organisms efficiency in N-fixation, producing organic acids and phyto-hormones as IAA, GA_3 and CKs, which led to increase P and K availability in plants rhizosphere, beside the higher P and K release capability of the micro-organisms in bio-fertilizer-1 if compared with Bio-fertilizer-2 (Ishac, 1989; Schroeder and Janos, 2005). All mentioned factors together led to produce higher yield as a result of incurring plant growth upshot improving plant chemical composition and metabolism.

The superior results obtained from bio-frtilizer-1 either under normal irrigation or water stress conditions, are because of the hyphal development of the mycrrohiza which play a big role in improving the soil mechanical texture out of the nature of fungal growth: in addition it plays as lateral roots exchanging the carbohydrate and the amino acids from the co-operated plant to the fungi, on the other hand, phosphate and other minerals from the fungus to the co-operated plant. Under water stress conditions, the hypha of mycrrohiza plays as an additional lateral root system providing the water from long distances away from the root system to the plants. (Hall and Fish,1979; Trans and Schenck, 1982).

Azotobacter crococcuma, as the second microorganism in the biofertilizer-1, helped in increasing nitrogen soil content through non-symbiotic nitrogen fixation pathway. This was producing plant growth promoting phyto-hormones such as IAA, GA_3 and CKs, which helps in encouraging plant growth, and organic acids therefore reducing soil pH, thus release the unavailable soil nutrients particularly zinc and phosphate especially under calcareous soil conditions. All these factors together led to enhance the photosynthetic pigments accumulation thus increase photosynthesis pathway as well as increased yield and its components (Devieln, 1969; Ishac, 1989 and Schroeder and Janos, 2005).

When NPK soil content is increased through mineral fertilization, the micro-organisms in both bio-fertilizers used the suitable NPK which added directly into soil instead of going through N-fixation. Unavailable P and K release pathway, by the mean of micro-organisms inhibition because of high soil content of NPK (Ishac, 1989; and Schroeder and Janos, 2005). This can illustrate the results observed under all studied water regime conditions. But once discussing the severe water stress conditions when missing 3rd or the 4th irrigation, plants faced complex challenges which seriously defend against implementing plant life cycle. Bio-fertilization remains alone capable to overcome the water stress hazard effects through producing growth promoting phyto-hormones such as IAA, GA_3 and CKS, beside the organic acids. Moreover, activate the enzyme phoshatase which help in releasing P and K in plant rhizosphere. Consequently, encourage the plant metabolism and improve the plant chemical compositions and growth, to be confirmed finally as significant increase in yield and its components (Kumar *et al.*, 2005).

CONCLUSION

Using the biological fertilization technique as an eco-friend source of NPK is urgently needed to save the environment and reduce the running costs of crops production particularly in the new reclaimed areas, and to avoid the inapplicable risks of applying the mineral fertilization under water stress conditions.

Using the biofertilizer-1 alone is highly recommended under water stress conditions, while it is permissible accompanied with the half of the recommended dosage of mineral NPK when irrigation water is sufficient enough.

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إنتاجية الذرة الشامية تحت ظروف الإجهاد المائي والتسميد الحيوي بالأراضي الجيرية

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أجريت تجربتان حقليتان في موسمين متتاليين ٢٠٠٣- ٢٠٠٤ بمحطة مركز بحوث الصحراء بمريوط لدراسة إستجابة نباتات الذرة صنف بايونير (٣٠ ب ٩) لمعاملتان من التسميد الحيوي (ن بو فو) ; الأولي(أزوتوباكتر كروكوككم + ميكرهيزا + أنواع من السيدوموناس) والثانية (أزوسبيريللم ليبوفرم + باسيلس ميجاثيرم المتخصص علي الفوسفات + باسيلس سابتيلس) ،كلا المعاملتين مصحوب بمستويين من التسميد المعدني (ن بو فو) الأول معدل سمادي كامل والثاني نصف المعدل السمادي المعتاد ، وذلك تحت أربعة مستويات من الري ، والتي تضمنت بدورها حرمان رية واحدة من إجمالي عدد الريات لكل معاملة كالتالي (حرمان الرية الثانية ، حرمان الرية الثالثة، حرمان الرية الرابعة) بجانب الري الطبيعي كمعاملة مقارنة.

ولقد أثبتت النتائج المتحصل عليها أن الماء من أهم العوامل المحددد لإنتاج الذرة ، في حين يمكن للنباتات أن تقاوم نقص المياه خلال فترة النمو الخضري والتي تمتد إلي ٦٠ يوما. حيث تأثرت النباتات سلبيا بشدة من جراء حرمانها من الرية الرابعة ثم الثالثة مقارنة بباقي المعاملات، في حين كانت معاملة المقارنة متبوعة بحرمان الرية الثانية من أفضل المعاملات.

ولقد ساعد التسميد الحيوي بوجه عام النباتات في مقاومة التأثير السيئ للإجهاد المائي في كل مراحل النمو المختلفة. ولقد ظهر أن السماد الحيوي الأول (أزوتوباكتر كروكوككم + ميكرهيزا + أنواع من السيدوموناس) أكثر فاعلية تحت ظروف الإجهاد المائي من السماد الحيوي الثاني (أزوسبيريللم ليبوفرم + باسيلس ميجاثيرم المتخصص علي الفوسفات + باسيلس سابتيلس). كما أظهرت النتائج أن الجرعة الكامله المعتادة من السماد المعدني (ن فو بو) كانت أفضل المعاملات السمادية، وتبعها في ذلك تفاعل نصف الجرعة المعتادة من السماد المعدني مع كل من السماد الحيوي الأول ثم الثاني علي الترتيب. ولكن عند الأخذ في الأعتبار التكلفة البينية فإن تطبيق نصف الجرعة من السماد المعدني مع السماد الحيوي الأول أو الثاني تبدو أكثر واقعية.

ولقد أظهرت النتائج، أنه تحت ظروف الري العادي فإن المعدل الكامل من السماد المعدني، متبوعاً بتفاعل نصف معدل السماد المعدني مع كل من السماد الحيوي الأول ثم الثاني قد أدي إلي زيادة معنوية في جميع قياسات النمو (إرتفاع النبات، الوزن الغض والجاف للنباتات، ومساحة الأوراق)، كما أدت إلي زيادة معنوية في الصبغات الكلية، الكلوروفيل الكلي، محتوي الحبوب من (ن، فو، بو)، وجميعها أدت بدورها إلي زيادة معنوية في وزن الكوز، عدد الحبوب بالكوز، وزن الـ ١٠٠ حبة وبالتالي زيادة المحصول البيولوجي والحبوب معنويا.

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EFFECT OF PHOSPHORUS AND POTASSIUM FERTILIZATIONS ON YIELD AND QUALITY COMPONENTS OF PEANUT (*Arachis hypogaea* L.) AT THE NORTH SINAI AREA IN EGYPT

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Two field experiments were carried out on the sandy soils with drip irrigation system at El-Sheakh Zowied Research Station of the Desert Research Center, North Sinai Area, in Egypt, during 2001/2002 and 2002/2003. All field trials were performed with the aim of studying the effect of three levels of phosphorus (15.5, 31.0 and 46.5 kg P_2O_5/fed.) and three levels of potassium (24, 36 and 48 kg K_2O/fed.) on productivity and quality components in three peanut (*Arachis hypogaea*, L.) varieties (namely,Giza-5, Giza-6 and Ismailia-1). The obtained results showed that the Ismailia-1 registered variety was superior to Giza-5 or Giza-6 according to yield and yield components. In addition, phosphorus fertilizer at the rate of 46.5 kg P_2O_5/fed. combined with potassium fertilizer at the rate of 48 kg K_2O/fed. have been given the highest significant values for seed yield (341.47 kg/fed.), for quality, yield and yield parameters. The phosphorus levels were significant for all varieties plant height, number of pods/plant, 100-seed weight and shelling percentage. Phosphorus and potassium levels showed significant effects inducing the highest 100-seed weight, shelling percentage, seed yield/fed., seed oil percentage and oil yield/fed. The three-factors interaction among the varieties, phosphorus and potassium levels proved to be highly significant as they induced the highest number of branches/plant and shelling percentage. It is concluded that Ismailia-1 was found to be the best that the utilize of the highest rates (46.5 kg P_2O_5/fed. and 48 kg P_2O_5/fed.). The varieties Giza-5, Giza-6 and Ismailia-1 gave the highest significant seed yield/fed. under the drip saline water irrigation conditions on sandy soil and combination of them can be recommended for the peanut.

Keywords: peanut (*Arachis hypogaea*, L.), El-Sheakh Zowied, North Sinai of Egypt, varieties, phosphorus and potassium fertilizers, salinity, quality, yield, yield components.

Peanut (*Arachis hypogaea*, L.) is one of the most important oil crops and food seed legume. It contains about 50% oil, 25-30% protein, 20% carbohydrates and 5% fiber and ash and makes a substantial contribution to human nutrition. In Egypt, oil production is not sufficient for the local consumption. So, it is of great importance to improve peanut production by several agricultural practices such as selecting promising varieties and applying balanced fertilization at a proper rate. Peanut crop can be grown successfully on the light textured soils, if conditions are favorable. On the other hand, soils of North Sinai Area's could be a promising area for the cultivating of this crop. Importance of this area can be increase when El-Salam channel completed, however, conditions of soil, its fertility and quality of the irrigation water may constitute a current problem for planting this crop at the wide scale. This research is an attempt to introduce peanut crop in this area under the condition of high soil salinity and irrigation water. This may necessitate beside the introduction of the crop a study to compare a number of promising varieties under different dosage applications of phosphorus and potassium fertilizers. Several investigators showed peanut varieties, differences in weight of pods; seed yield/plant, 100-seed weight and seed yield/fed. Among them, Shams El-Din and Ali (1996) recorded significant differences among peanut varieties in shelling percentage, as well as oil and protein yields/fed. Phosphorus considered being one of the important nutrients that required in large amount for the optimum growth, yield and quantity in oil seeds. Peanut responds well to higher levels of phosphorus fertilizations, especially in saline soil conditions. Peanut yields appeared to be gradually increased as P level increased under several conditions as reported by Patel (1992). Regarding potassium fertilizer, Patra *et al.* (1996) showed a positive response in yield of peanut to K fertilizer. Saha *et al.* (1994) indicated that, pod yield and yield components increased by K application. In addition, Patra *et al.* (1995) found that application of 45 kg K_2O/fed. increased the yield and yield components of the peanut. El-Far and Ramadan (2000) observed that application of 36 kg K_2O/fed. significantly increased number of branches/plant, pods weight/plant, 100-seed weight, shelling percentage and pods yield/fed. in peanut. Similarly, Darwish *et al.* (2002) were noticed that adding 48 kg K_2O/fed. fertilizer was significantly increased seed and oil yields/fed. of peanut. Anton and Bassiem (1998) indicated that 100- seed weight and pod, and seed yields/ fed. of peanut were responded positively to application of potassium up to 48 kg/fed. under the sandy soils, peanut may required P , K fertilizers to improve the pods production and their quality. Nasr-Alla *et al.* (1998)

indicated that the number of branches/plant, yield of pods/plant, and per fed. of peanut increased as the rate of P and K increased as individual or combine. El-Far and Ramadan (2000) showed that application of 46.5 kg P_2O_5/fed. and 36 kg K_2O/fed. application had a highly significant positive effect on yield of peanut. The objective of this investigation was to study the response of yield components of some peanut varieties to phosphorus and potassium fertilizers under the conditions of sandy soil and irrigation with saline water using (2420ppm) drip irrigation system at El-Sheakh Zowied Research Station of the Desert Research Center, in North Sinai Area, in Egypt, during 2001/2002 and 2002/2003.

MATERIALS AND METHODS

Two field trials were carried out at El-Sheakh Zowied Research Station of the Desert Research Center at North Sinai governorate during the 2001/2002 and 2002/2003 to study the effect of phosphorus and potassium fertilizers on quality, yield and yield components in some peanut (*Arachis hypogaea*, L.) varieties (namely;Giza-5, Giza-6 and Ismailia-1).The experimental site's soil was sandy and irrigated through a drip irrigation system with water having 2420ppm salts. Physical (Black, 1965) and chemical (Jackson 1958) properties of the experimental soil was given in table (1).Irrigation water was analyzed to determine its contents of anions and cations at El-Sheakh Zowied Research Station (Table 2).The experimental treatments were designed as a split-split plot technique with four replicates. The main plots represented as the three varieties of peanut; namely Giza-5, Giza-6 and Ismailia-1 and sub-plots are three levels of phosphorus fertilization. Sub-sub-plots were designed as three levels of potassium fertilization; namely (24, 36 and 48 kg K_2O/fed.) (feddan = fed. = 4200 m^2). Phosphorus source was calcium super phosphate, which was applied at the rates of 15.5, 31.0 and 46.5 kg P_2O_5/fed. It was applied before sowing during the seedbed preparation. Another fertilizer is potassium, was applied in three equal doses such as (I)at sowing,(II)20 days after sowing and (III)40 days after sowing. The size of the experimental plot (sub-sub-plot) was 3x3.5m (= 10.5 m^2 = $^1/_{400}$ fed.), which included 7 rows. The rows were 0.5m apart and on row plants distance were 0.20 m. Seeding rate was 50kg peanut seeds/fed. Sowing was made on May 15, 2001 and May 18, 2002. Seeds were treated with vitavex prior to sowing. Three seeds were applied per hill then each hill was thinned after two weeks from sowing as two plants per hill. Nitrogen fixing bacterial strain was directly given into the soil after sowing. Ammonium sulfate (2o.5%N) fertilizer was applied at the rate of 30kg N/fed. at two equal doses; at sowing and 20 days afterwards. In addition, gypsum was applied at the beginning of flowering stage at the rate of 0.5ton/fed. Farmyard manure (FYM) at the rate of 20m^3/fed., was thoroughly mixed with 30cm upper part of the soil during the seedbed preparation. The chemical composition of the FYM is listed in table (3). At harvest (105 days from sowing), the following characters were estimated on ten random plants in each sub-sub-plot in both seasons: plant height cm, number of branches/plant, number of pods/plant, pods weight/plant gm, seed weight/plant gm, 100-seed weight gm and shelling percentage. The latter is calculated from the following equation:

Shelling percentage = Seed yield (kg/fed.) / Pod yield (kg/fed.) X 100

In addition, a 3m^2 plot in the middle of each replicate plot was harvested. Pods yield kg/fed., seed yield kg/fed., seed oil percentage and oil yield kg/fed., were estimated. Dry mature seeds were ground into very fine powder to determine oil percentage using Soxhlet apparatus and diethyl ether according to A.O.A.C. (1990). Oil yield was estimated by multiplying seed oil percentage by seed yield kg/fed. All obtained data was subjected to statistical analysis according to the procedures of analysis of variance (Snedecor and Cochran, 1981) and the least significant difference test was used to compare of the means (Gomez and Gomez, 1984).

TABLE (1). Some physical and chemical properties of representative soil sample from the experimental site

Soil property	**Soil depth (cm)**	
Partice size distribution	**0-30**	**30-60**
Sandy %	98.50	98.18
Silt %	0.69	0.85
clay %	0.51	0.57
Textural class	sandy	sandy
Organic matters %	0.023	0.052
PH (1: 1 water soil suspension)	7.81	7.83
EC (ds m^{-1})	0.68	0.75
$CaCO_3$ %	1.45	1.31
Soluble cations (meq / 100 g)		
Na^{+1}	1.56	1.16
K^{+1}	0.17	0.22
Ca^{+2}	1.04	1.25
Mg^{+2}	0.35	1.05
Soluble anions (meq 100 g)		
Cl^{-1}	1.05	1.11
HCO_3^{-1}	0.87	1.21
SO_4^{-2}	1.20	1.74

TABLE (2). The average values of chemical analysis of the used irrigation waters.

Season	pH	EC ppm	Soluble anions (meq/ L)				Soluble cations (meq/ L)			
			Ca^{+2}	Mg^{+2}	Na^{+1}	K^{+1}	CO_3^{-2}	HCO_3^{-1}	SO_4^{-2}	Cl^{-1}
2001/2002	8.1	2276	4.89	6.07	26.09	0.18	0.54	2.32	12.91	19.74
2002/2003	8.3	2565	5.47	7.37	26.93	0.19	0.68	3.07	10.58	26.31

TABLE (3). Some chemical properties of the applied farmyard manure

PH	EC ds/m	organic matter %	C%	N%	C/N
7.42	1.74	54.22	31.52	2.21	14.26

RESULTS AND DISCUSSION

1- Effect of the Seasonal Variations

Results in table (4) represent averages of the studied seasons. It is obvious from the results that all of the studied characters were showed significant differences between years. Greater yield and yield components in the first year as compared with those in the second can be explained with the salt accumulation and non-residual effects. This parameter was prominent in the number of pods/plant and weight of the 100 seeds (Table 4). These findings are in harmony with those found by El-Hosary *et al.* (2000).

TABLE (4). The average of seasonal effect on yield and yield components of peanut plants under the saline conditions at El-Sheakh Zowied.

Seasons	Plant height (cm)	Number of branches/ plant	Number of pods/ plant	Pod weight/ plant (gm)	Seed weight/ plant(gm)	100-seed weight (gm)	Shelling %	Pod yield (kg/fed.)	Seed yield (kg/fed.)	Seed oil %	Oil yield (kg/fed.)
2001/2002	26.03	7.97	10.01	11.20	5.06	42.36	45.08	717.46	306.56	38.39	118.71
2002/2003	28.77	7.31	9.46	10.64	4.71	41.44	44.01	582.39	240.97	36.59	89.99
L.S.D.	0.40	0.07	0.31	0.13	0.19	0.38	1.03	14.36	11.47	0.40	5.91

*L.S.D. at 0.05 level.

Effect of the Used Varieties

Data in yable (5) indicate that there are significant differences among the studied varieties as averaged across other treatments and both years of the study in approximately all studied traits. Ismailia-1 could significantly surpassed Giza-5, for investigated parameters such as plant height, no. of branches/ plant, no. of pods/ plant, pods weight/ plant, seed weight/ plant, 100- seed weight, shelling percentage, pods/ yield/ fed., seed yield/ fed., oil percentage in seeds, and oil yield/ fed. Inherited genetic variability reflects to each variety more than effects imposed on the plants by the applied treatments. These findings are in line with Sarhan (2001), and Abd–Alla (2004) and Ali *et al.* (2004). Generally, Ismailia-1 surpassed Giza-6 and Giza-5 for the most yields and yield components in this study.

TABLE (5). Effect of varieties, Phosphorus and potassium fertilizers on yield and yield components of peanut under the saline conditions at El- Sheakh Zowied.

Treatments	Plant height (cm)	Number of branches/ plant	Number of pods/ plant	Pod weight/ plant(gm)	Seed weight/ plant(gm)	100-seed weight (gm)	Shelling %	Pod yield (kg/fed.)	Seed yield (kg/fed.)	Seed oil %	Oil yield (kg/fed.)
Peanut varieties											
Giza 5	24.33	6.45	8.52	9.62	4.11	40.28	42.84	575.93	230.68	35.91	83.59
Giza 6	28.06	7.94	9.88	11.08	4.97	41.96	44.71	661.72	278.61	37.64	99.80
Ismailia-1	29.81	8.52	10.80	12.05	5.59	43.46	46.08	712.13	312.01	38.92	127.65
L.S.D.	0.49	0.09	0.38	0.15	0.23	0.46	1.26	17.59	14.04	0.49	7.24
Phosphorus levels (kg/fed)											
15.5	24.86	6.66	8.74	9.98	4.31	40.80	43.14	596.86	242.57	36.51	89.90
31	27.16	7.84	9.83	10.95	4.91	41.94	44.64	651.84	274.57	37.44	104.26
46.5	30.19	8.42	10.63	11.82	5.45	42.96	45.85	701.07	304.16	38.51	118.89
L.S.D.	0.41	0.17	0.15	0.24	0.09	0.20	0.33	15.03	4.38	0.19	2.56
Potassium levels (kg/fed)											
24	26.13	6.68	9.08	10.00	4.36	40.85	43.26	596.77	242.97	38.46	93.45
36	27.26	7.34	9.89	10.94	4.87	41.91	44.57	653.15	272.76	37.42	103.36
48	28.81	7.90	10.25	11.81	5.44	42.94	45.80	699.86	305.57	36.59	111.81
L.S.D.	0.53	0.11	0.13	0.11	0.09	0.14	0.14	6.03	3.05	0.09	2.15

*L.S.D. at 0.005 level.

Effect of Phosphorus Application

It was observed a clear increase the P levels from 15.5 to 46.5 kg P_2O_5/fed.; gradually increased all yield components for the plant height, number of branches/plant, number of pods/plant, pods weight/plant, seed weight/plant, 100-seed weight, shelling percentage, pods yield/fed., seed yield/fed., oil percentage in seeds, and oil yield/fed. (Table 5). Since P fertilization had promising effects on yield and yield components which resulted in producing more pods, seeds and oil yields per unit area. Similar results were obtained by Anton and Bassiem (1998), and El-Far and Ramadan (2000) who indicated that increasing P levels was always induced the increasing in yield and yield parameters of peanut. This can be explained as the phosphorus mineral encourages the cell division and cell elongation in the meristematic region of the plant, besides the nitrogen fixation. The increase in vegetative growth owing to P application induced more pods/ plant production and improved seed weight. In this respect, maximum pod weight/ plant up to 11.82 gm / plant was recorded with application of 45.5 kg P_2O_5 /fed., however it was 18.44 % higher over the control (15.5 kg P_2O_5 /fed.) These effects could be reflected in overall yield of crop, recording the highest pods yield/ fed, seed yield/ fed. and oil yield/ fed. by 701.07 kg, 304.16 kg and 118.89 kg with 46.5 kg P_2O_5 /fed , being 17.46%, 25.39% and 32.25% higher over the control treatment (15.5 kg P_2O_5 /fed.), respectively (Table5). The results are in accordance with MaJumdar *et al.* (2001).who mentioned that application of P significantly increased seed oil percentage of peanut and also the application of 31 and 46.5 kg P_2O_5 /fed., increased of the seed oil percentage in peanut significantly as compared with 15.5 kg P_2O_5. This increase represents 2.55% and 5.48%, respectively. Shelling percentage increased significantly with 46.5 kg P_2O_5 /fed. by 5.87 % over 15.5 kg P_2O_5 /fed. (Table 5). Observed improvement in the yield of peanut was attributed to the increase of P application which resulted in root development. These results agreed with and verified by Samanta *et al.* (1993) and Rao *et al.* (2002).

Effect of Potassium Application

Levels of potassium fertilizer had a highly significant effect on all studied traits for the plant height, number of branches/plant, number of pods/plant, pods weight/plant, seed weight/plant, 100-seed weight, shelling percentage, pod yield/fed., seed yield/fed., seed oil %, and oil yield/fed. (Table 5).This effect can be explained as its essential role in growth and establishment of peanut plants. In addition, this mineral has an important rate of the plants as a part and functioning of enzymes in all plant biological processes, which leads to increasing yield components. In this respect, Patra *et al.* (1995) and Nasr-Alla *et al.* (1998), are in agreement with and verified these results. Researchers found that potassium application proved to be highly beneficial for plants in general and shelling percentage, pod and seed yields/fed. which, gradually increased with K level increased from 24 to 36 and 48 kg K_2O/fed. This increases represent 5.87%, 17.27%, 25.76% 19.7% in combined data for both seasons. Obtained results followed the same patterns of other yield attributes confirmed the vital role of K element in growth and improvements of productivity of peanut. Such results may due to adequacy of K applied that in turn favors the plant growth and productivity of peanut. These results means that soil K content is not fairly enough for the requirements of peanut under such conditions. Similar results were obtained by Ahmed and Zeidan (2001), and Darwish *et al.* (2002).

Application of 48 kg K_2O/fed. gave the highest values of all investigated yield and yield components (Table 5). But, Dahdouh (1999) and Ali and Mowafy (2003) indicated that increasing potassium fertilizer rate from 24 to 48 kg K_2O/fed. induced a significant reduction of oil percentage in seeds on sandy soil. Researcher attributed such decrement for oil percentage from the seeds to the dilution effect including increase of seed size and weight. In this connection, Anton and Bassiem (1998) stated that seed oil percentage slightly increased when peanut plants received high value of K fertilizer at the rate of 48 kg K_2O/fed.

Effect of Interaction Between Varieties and Phosphorus

Table (6) indicates that plant height, number of pods/plant, 100-seed weight and shelling percentage increased significantly as 32.94, 11.72, 44.58 and 47.74% for Ismailia-1 when phosphorus fertilizer dosage increased to 46.5 kg P_2O_5/fed. But number of branches/plant, pod weight/plant, seed weight/plant, pod yield/fed., seed yield/fed., seed oil percentage, and oil yield/fed. were not significantly affected by this interaction treatment compared with the others (Giza-5 and Giza-6 adopted in this study). Obtained results revealed that phosphorus fertilization highly significantly increase the shelling percentage for all varieties as 44.09%, 45.71% and 47.74% from Giza-5, Giza-6 and Ismailia-1 respectively. The highest shelling percentage was obtained from 46.5 kg P_2O_5/ fed. fertilization and the lowest shelling percentage was obtained from 15.5 kg P_2O_5/ fed. fertilization (Table 6). This point indicates that phosphorus has a vital role for increasing seeds weight on pod. Results were verified by Ali *et al.* (1995) and El-shahat (2001) who found that plants of Ismailia-1 variety could significantly surpass those of the other two varieties under study. Such results indicated that a greater efficiency in Ismailia-1 for the utilizing of phosphorus as compared with another two varieties (Giza-5 and Giza-6) under the environmental conditions of this study. All obtained results were agreed with Ali (1990) and Patra *et al.* (1996) and Migawer *et al.* (2001).

TABLE (6). Effect of interaction between varieties and phosphorus fertilizer on yield and yield components of peanut plants under the saline conditions at El- Sheakh Zowied.

Peanut Varieties	Phosphorus levels (kg/fed)	Plant height(cm)	Number of branches/plant	Number of pods/plant	Pod weight/plant(gm)	Seed weight/plant(gm)	100-seed weight (gm)	Shelling %	Pod yield (kg/fed)	Seed yield (kg/fed)	Seed oil %	Oil yield (kg/fed)
Giza 5	15.5	21.91	5.31	7.59	8.67	3.50	39.39	41.48	521.16	199.95	34.78	70.04
	31.0	24.09	6.70	8.44	9.63	4.15	40.17	42.95	577.93	231.32	35.79	83.47
	46.5	26.99	7.35	9.54	10.56	4.67	41.28	44.09	628.70	260.76	37.14	97.51
Giza 6	15.5	26.12	6.92	8.96	10.18	4.48	40.64	43.73	610.59	248.94	36.76	92.42
	31.0	27.44	8.20	10.02	11.08	4.91	42.24	44.71	658.79	276.27	37.70	105.27
	46.5	30.63	8.70	10.65	12.00	5.52	43.01	45.71	715.76	310.62	38.48	120.68
Ismailia-1	15.5	26.54	7.75	9.68	11.09	4.94	42.37	44.21	658.84	278.81	38.01	107.03
	31.0	29.95	8.62	11.01	15.15	5.67	43.42	46.21	718.81	316.12	38.89	124.04
	46.5	32.94	9.20	11.72	12.90	6.16	44.58	47.74	758.74	341.09	39.91	138.48
L.S.D.		0.70	N.S.	0.26	N.S.	N.S.	0.34	0.57	N.S.	N.S.	N.S.	N.S.

*L.S.D. at 0.05 level. N.S.= not significant

Effect of Interaction Between Varieties and Potassium

Pods weight/plant, seed weight/plant, 100-seed weight, shelling percentage, pods yield/fed., seed yield/fed., seed oil percentage, and oil yield/fed. increased significantly (13.03 gm , 6.24 gm , 44.41 gm ,47.62 %, 762.21 kg /fed.,349.49 kg /fed.,37.90 %.,132.46 kg/fed.) respectively for the investigated varieties by increasing potassium application rate up to 48 kg K_2O/fed., While plant height, number of branches/plant and number of pods/plant were not significantly, 31.09 cm, 9.09 branches/plant, 11.35 pods/plant affected (Table7). Ismailia-1 showed greater positive response regarding the studied parameters if compared with Giza-5 and Giza-6 in respect of the highest values for the mentioned parameters(Table7). Seed oil percentage did not follow a clear trend regarding its response but pods, seed and oil yields /fed. were found to be higher in Ismailia-1 than other cultivars. In addition, Ismailia-1 had the highest pod, seed and seed oil yields/fed. in response to application of 48 kg K_2O /fed. fertilization has been given the highest values for examined yield and yield components and the increases happened gradually with 24 to 36 and 48 kg K_2O/fed. (Table7). Obtained results agreed with Ahmed and Zeidan (2001). Migawer *et al.* (2001) and Abd-Alla (2004).

TABLE (7). Effect of interaction between varieties and potassium fertilizer on yield and yield components of peanut plants under the saline conditions at El-Sheakh Zowied.

Peanut Varieties	Potassium levels (kg/fed)	Plant height (cm)	Number of branches/ plant	Number of pods/plant	Pod weight/ plant(gm)	Seed weight/ plant(gm)	100-seed weight (gm)	Shelling %	Pod yield (kg/fed)	Seed yield (kg/fed)	Seed oil %	Oil yield (kg/fed)
Giza 5	24	23.19	5.79	7.95	8.84	3.72	39.07	41.88	527.89	206.34	36.77	75.87
	36	23.79	6.51	8.66	9.74	4.08	40.28	42.82	585.52	232.16	35.87	84.04
	48	26.00	7.06	8.96	10.28	4.52	41.49	43.82	614.38	253.53	35.08	88.94
Giza 6	24	26.73	7.35	9.19	10.05	4.35	40.98	43.28	599.21	242.84	38.57	93.66
	36	28.12	7.94	10.01	11.09	5.01	41.99	44.90	662.94	279.29	37.58	105.88
	48	29.35	8.54	10.44	12.11	5.55	42.92	45.97	723.01	313.69	36.79	115.41
Ismailia-1	24	28.47	7.95	10.09	11.12	5.01	42.51	44.63	663.20	279.71	40.04	111.99
	36	29.87	8.52	10.97	11.99	5.52	43.45	45.99	710.98	306.82	38.82	120.16
	48	31.09	9.09	11.35	13.03	6.24	44.41	47.62	762.21	349.49	37.90	132.46
L.S.D.		N.S.	N.S.	N.S.	0.18	0.15	0.24	0.24	10.45	5.29	0.16	3.72

*L.S.D. at 0.05 level. N.S.= not significant

Effect of Interaction Between Phosphorus and Potassium

Under sandy soil conditions, peanut requires P and K fertilizers to improve its dry matter pods production and its quality. Obtained data in table (8) indicate that the effect of interaction between phosphorus and potassium fertilization rates on yield and yield components of peanut are significant for

100-seed weight, shelling percentage, seed yield/fed., seed oil percentage and oil yield/fed. Generally, it was observed that increasing the levels of both nutrient elements markedly increased all the examined plant growth traits. The highest values of these parameters were recorded with the application of the highest rates of both elements. Therefore, the highest values of 100- seed weight (44.10 gm), shelling percentage (47.09%), seed yield (341.47 kg/fed.) and Oil yield (128.02 kg/fed.) were achieved by high level of 48 kg K_2O/fed. when 46.5 kg P_2O_5/fed. was applied. Otherwise, low levels of both fertilizers produced the lowest values of 100- seed weight, shelling percentage, seed yield fed. and oil yield/fed.(Table 8). On the other hand, observed results showed that increasing K level tended to decrease significantly seed oil%. However, the lowest seed oil % was obtained by high level of K 48 kg K_2O /fed. The highest oil yield/ fed. was achieved by the high level of K 48 kg K_2O by Yakadri *et al.*(1992). In this connection, Anton and Bassiem (1998) reported that pods weight/plant, seed weight/plant, straw weight/plant and 100-seed weight traits reached to maximum in response to the highest application rates for all nutrients. These results attributed to the beneficial simultaneous effect of P and K on both inoculums activity (rhizobium) and plant growth. These effects showed up in the form of enhanced growth parameters. Migawer *et al.* (2001) and Ali and Mowafy (2003) reported similar results. However, Dahdouh (1999), in sandy soil, proved that feeding peanut plants with 24, 36 up to 48 kg K_2O/fed. indicated a significant decrement in oil percentage of peanut seeds. On the other hand, increasing P application rate proved to increase oil yield (kg/fed.) significantly according to Anton and Bassiem (1998). This may due to the increase in P application from 30 to 50 kg P_2O_5/fed. combined with the application of 48 kg K_2O/fed. which increased seed oil content of peanut (Table 8).This can be explained on the basis of that increasing P and K together activated the formation of both amino and fatty acids.

TABLE (8). Effect of interaction between phosphorus and potassium fertilizers on yield and yield components of peanut plants under the saline conditions at El-Sheakh Zowied.

Phosphorus levels (kg/fed)	Potassium levels (kg/fed)	Plant height (cm)	Number of branches/ plant	Number of pods/ plant	Pod weight plant(gm)	Seed weight/ plant(gm)	100-seed weight (gm)	Shelling %	Pod yield (kg/fed.)	Seed yield (kg/fed.)	Seed oil %	Oil yield (kg/fed.)
15.5	24	24.01	6.00	8.10	9.15	3.87	39.92	42.06	546.81	216.26	37.39	80.86
	36	24.51	6.67	8.86	10.00	4.22	40.75	43.03	598.73	240.81	36.47	88.88
	48	26.06	7.31	9.26	10.80	4.83	41.73	44.33	615.06	270.61	35.68	96.55
31.0	24	25.66	7.32	9.17	10.03	4.35	40.89	43.18	596.28	244.05	38.42	93.76
	36	26.99	7.79	9.98	10.99	4.96	41.95	44.77	654.41	275.03	37.32	103.82
	48	28.83	8.11	10.33	11.83	5.42	42.99	45.98	702.81	301.63	36.59	111.46
46.5	24	28.73	7.76	9.96	10.84	4.86	41.76	44.55	645.21	268.59	39.57	106.28
	36	30.28	8.52	10.79	11.83	5.43	43.02	45.91	706.27	302.41	38.17	117.38
	48	31.55	8.98	11.15	12.79	6.06	44.10	47.09	751.73	341.47	37.19	128.02
L.S.D		N.S	N.S	N.S	N.S	N.S	0.24	0.24	N.S	5.29	0.16	3.72

*L.S.D. at 0.05 level. N.S.= not significant

Effect of Interaction Among Varieties, Phosphorus and Potassium

Data obtained for the interaction among the three tested factors (varieties x phosphorus x potassium) are depicted in Table (9). The results indicate that such interaction had a significant influence on the average number of branches/plant (9.85) and shelling percentage(49.47 %) in Ismailia-1. Enhanced values of yield were obtained in response to fertilizer treatment 46.5 kg P_2O5/fed. and 48 kg K_2O/fed. plants of Ismailia-1 variety significantly surpassed the other two varieties of Giza-5 and Giza-6 regarding the utilization of both phosphorus and potassium under the environmental conditions of this study at El-Sheakh Zowied in North Sinai. The Ismailia-1 peanut variety proved to be promising in the study area, especially under saline irrigation water conditions.

TABLE (9). Effect of interaction among varieties, phosphorus and potassium fertilizers on yield and yield components of peanut plants under the saline conditions at El- Sheakh Zowied.

Peanut varieties	Phosphorus levels (kg/fed)	Potassium levels (kg/fed)	Plant height (cm)	Number of branches/ plant	Number of pods/ plant	Pod weight/ plant (gm)	Seed weight/ plant(gm)	100-seed weight (gm)	Shelling %	Pod yield (kg/fed)	Seed yield (kg/fed)	Seed oil %	Oil yield (kg/fed)
Giza 5	15.5	24	21.78	4.85	7.25	8.10	3.30	38.45	40.58	486.45	181.32	35.65	64.64
		36	20.87	5.20	7.63	8.74	3.28	39.23	41.20	525.37	199.68	34.70	69.90
		48	23.07	5.88	7.88	9.18	3.93	40.48	42.65	551.67	218.85	34.00	74.41
	31.0	24	22.57	5.83	7.82	8.80	3.69	38.95	41.87	528.13	206.68	36.57	75.58
		36	23.70	6.95	8.62	9.82	4.22	40.15	42.90	589.82	233.92	35.77	84.22
		48	26.00	7.32	8.89	10.27	4.53	41.42	44.08	615.85	253.35	35.03	88.75
	46.5	24	25.22	6.68	8.77	9.63	4.17	39.82	43.20	569.10	231.03	38.10	88.02
		36	26.82	7.39	9.73	10.67	4.74	41.45	44.37	641.37	262.87	37.13	98.02
		48	28.93	7.97	10.11	11.38	5.10	42.58	44.72	675.63	288.38	36.20	104.39
Giza 6	15.5	24	24.97	6.12	8.27	9.17	3.91	39.75	42.48	547.98	214.20	37.53	80.39
		36	26.07	6.81	9.14	10.22	4.50	40.68	43.87	613.65	250.75	36.73	92.83
		48	27.33	7.84	9.48	11.14	5.01	41.50	44.83	670.15	281.88	36.00	101.48
	31.0	24	26.17	7.86	9.29	10.03	4.28	41.22	43.15	593.87	241.93	38.67	93.55
		36	27.22	8.07	10.14	11.04	4.99	42.22	44.98	658.12	278.00	37.60	105.28
		48	28.95	8.68	10.64	12.17	5.45	43.28	45.98	725.40	308.87	36.83	113.76
	46.5	24	29.05	8.07	10.01	10.94	4.85	41.97	44.20	655.77	272.40	39.50	107.60
		36	31.07	8.93	10.74	12.01	5.52	43.07	45.85	717.05	309.13	38.40	119.52
		48	31.77	9.11	11.19	13.03	6.18	43.98	47.08	774.47	350.32	37.53	131.47
Ismailia-1	15.5	24	25.27	7.04	8.79	10.17	4.40	41.55	43.10	606.00	253.25	39.00	98.77
		36	26.58	7.99	9.81	11.04	4.89	42.33	44.03	657.17	272.08	37.97	103.92
		48	27.77	8.21	10.43	12.07	5.54	43.22	45.50	713.35	311.10	37.05	115.26
	31.0	24	28.23	8.28	10.39	11.26	5.08	42.50	44.53	672.83	283.53	40.02	113.47
		36	30.07	8.34	11.19	12.13	5.66	43.48	46.42	715.40	313.17	38.60	121.97
		48	31.55	9.22	11.47	13.06	6.28	44.28	47.88	768.18	351.67	37.90	133.28
	46.5	24	31.92	8.54	11.10	11.94	5.55	43.48	46.25	710.77	302.35	41.10	124.26
		36	32.97	9.22	11.90	12.81	6.01	44.53	47.52	760.38	335.22	39.88	134.60
		48	33.95	9.85	12.15	13.95	6.91	45.73	49.47	805.08	385.72	38.75	149.46
L.S.D.			N.S.	0.32	N.S.	N.S.	N.S.	N.S.	0.42	N.S.	N.S.	N.S.	N.S.

*L.S.D. at 0.05 level. N.S.= not significant

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تأثير التسميد الفوسفاتي والبوتاسى على المحصول ومكونات الجودة فى الفول السودانى بمنطقة شمال سيناء فى مصر

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أقيمت تجربتان حقليتان بمحطة بحوث الشيخ زويد التابعة لمركز بحوث الصحراء بمحافظة شمال سيناء خلال صيف موسمي ٢٠٠١/٢٠٠٢، ٢٠٠٢/٢٠٠٣ لدراسة تأثير مستويات التسميد الفوسفاتي (١٥,٥، ٣١,٠، ٤٦,٥ كجم فو٠أ٥/فدان) ومستويات التسميد البوتاسى (٢٤، ٣٦، ٤٨ كجم بو٠أ/فدان) على جودة وإنتاجية ثلاثة أصناف من الفول السوداني (جيزة ٥، جيزة ٦، إسماعيلية ١) تحت ظروف الأراضي الرملية ونظام الرى بالتنقيط بمياه الآبار التى تحتوي على أملاح كلية تقدر بنحو ٢٤٢٠ جزء في المليون وكانت أهم النتائج المتحصل عليها مايلي:

تفوق الصنف إسماعيلية ١ على بقية الأصناف في كل الصفات تحت الدراسة. كما تفوق معدل التسميد الفوسفاتي (٤٦,٥ كجم فو٠أ٥/فدان) ومعدل التسميد البوتاسى (٤٨ كجم بو٠أ/فدان) مقارنة بمستويات التسميد الفوسفاتي والبوتاسي الأخرى وقد أدى ذلك إلى زيادة كل الصفات تحت الدراسة. وقد أظهر التفاعل بين الأصناف والتسميد الفوسفاتي تأثير معنوي على طول النبات، عدد القرون للنبات، وزن المائة بذرة، نسبة التقشير % . كذلك أظهر التفاعل بين الأصناف والتسميد البوتاسى تأثير معنوي على وزن قرون النبات، وزن بذور النبات، وزن المائة بذرة، نسبة التقشير %، محصول القرون/فدان، محصول البذور/فدان، نسبة الزيت %، محصول الزيت/فدان. بينما أدى التفاعل بين السماد الفوسفاتي والبوتاسى إلى حدوث زيادة معنوية في وزن المائة بذرة، نسبة التقشير %، محصول البذور/فدان، نسبة الزيت، محصول الزيت/فدان. وقد أدى التداخل بين الأصناف والتسميد الفوسفاتي والبوتاسى تأثير معنوي في عدد فروع النبات، ونسبة التقشير%.

من خلال الدراسة يمكن التوصية بإدخال وزراعة الفول السوداني فى شمال سيناء ومع دخول مياة النيل بترعةالسلام يوصى بزراعة أصناف ذات إنتاجية عالية خاصة الصنف إسماعيلية- ١. مع الأهتمام بالمعاملات الزراعية حيث أنها أراضى رملية على أن يتم الرى بالتنقيط مع مراعاة الإهتمام بإضافة التسميد الفوسفاتي والبوتاسى بمعدلات ٤٦,٥ كجم فو٠أ٥/فدان، و ٤٨ كجم بو٠أ/فدان على الترتيب.